Our reference:
P10304 DE, P10414 DE, P10454 DE
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Patent Application

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Method for Producing Dental Impression Materials, and Devices Therefor

The invention relates to a system having low flow resistance, in particular for intrinsically viscous pastes such as dental materials of various consistencies, dynamic mixers and mixing elements suitable for this purpose, the production of dental impression materials, and methods for mixing components of impression materials, in particular polyether impression materials, and the use of a chamber mixer.

Multi-component mixed systems for product end users have become widespread, particularly in the dental field. On the one hand, these involve hand-operated devices for double cartridges by which materials in relatively small quantities and having low viscosities are mixed in a static mixer. On the other hand, there are motorized mixing devices which, in addition to material conveying, also drive a dynamic mixer having rotating mixing elements. Materials from cartridges as well as from foil bags may be processed in these devices. The devices of this type, which in the meantime have become widely used in the dental field, are directed to two components in a mixing ratio of 5:1.

The mixing energy is generated by the rotating interior part of the mixer, which admixes the two components into a homogeneous mass when they flow through the mixing nozzle.

The problem described in EP 0 993 863/US 6,244,740, EP 1 029 585, and EP 1 099 470/US 6,523,992 for these unequal component quantities is a fluctuating mixing ratio at the start of conveying, which in the cited documents was solved by deflecting the component having the larger volume through a duct, and introducing same into the common mixing chamber at a later time than for the component having the smaller volume.

EP 1 072 323 A1 also describes a mixing device for use in the dental field which is capable of processing the components not only in a 5:1 ratio but also in a 1:1 ratio.

However, such a system, which is not incompatible with existing devices, has tremendous marketing problems on account of the high added capital costs for the end user.

In terms of quantity, the impression materials having a kneadable consistency constitute a very large percentage of impression materials used in dentistry. However, it is precisely this consistency that heretofore has hindered their processing in automatic mixing systems.

On the one hand, the devices approach their operating limits with regard to discharge of the substances, and on the other hand, due to the high friction the dynamic mixer causes undesired heat to be introduced into the product. The reaction rate of the multi-component pastes is greatly dependent on temperature. Such pastes remain in the paste-like state for sufficiently long periods at room temperature, and then as the result of the higher temperature in the mouth are rapidly cured to form an elastomer. The introduction of heat during mixing, which is different for each type of device, results in formation of elastomeric fractions even outside the oral cavity, which can lead to a distorted impression.

Impression materials used in dentistry are typically two-component masses which crosslink at room temperature to form elastomeric reaction products. These masses are based primarily on crosslinkable silicones or crosslinkable polyethers.

In particular in the dental field, chemically curing pastes are provided in double cartridges or tubular bags, which the user simultaneously meters, conveys, and mixes in the device. The mixing is performed by mixing attachments, for example dynamic mixers, connected to the double cartridges or tubular bags. Examples of such mixers are described, for example, in DE 199 51 504 A1, DE 199 47 331 C2, DE 101 12 904 A1, DE 100 43 489 A1, and DE 100 15 133 C1.

Since very different consistencies are used for various applications, there is a need to develop a mixing attachment which is universally applicable for all these consistencies. An object of the present invention is to provide such a mixing attachment or dynamic mixer.

For low-viscosity consistencies, the best intermixing is obtained by high shear in narrow gaps. Due to the increasing use of these mixing devices also for high-viscous pastes, it has become necessary to construct mixer attachments provided with higher flow cross sections, since otherwise the highly viscous consistencies result in objectionably high conveying forces and undesirable heating of the mixing material.

For the low-viscous, in particular intrinsically viscous, pastes having pronounced flow boundaries, as a result of these expanded flow cross sections intermixing of the components occurs only in the region at the surfaces of the rotor and stator. In regions of greater layer thickness this then leads to plug flow. As a result, poor-quality or even unmixed paste fractions are discharged from the mixer.

For mixers whose blades have a maximum extension to the wall of the mixing chamber, a good mixing effect is provided in the outer region of the mixing chamber due to the high peripheral velocity present there. In the layer between the mixer shaft

and this outer region, however, the conveyed paste in the form of a plug may rotate along with the interior part of the mixer if no flow perturbation elements are present.

The flow perturbation elements typically used in process equipment engineering are installed on the outer walls of the tube or vessel. For the dynamic mixers considered herein, the flow perturbation elements are injection-molded parts made of plastic, intended for disposable use and preferably comprising the fewest possible parts and being simple to manufacture. A flow perturbation element for the wall of the mixer housing cannot be manufactured using simple injection molds.

Extensions of the shaft diameter which revolve around the mixer shaft have proven to be easily designed flow perturbation elements. These diameter extensions which project radially into the mixing chamber reduce the flow cross section at this location, and thereby force the paste from the plug flow and temporarily increase the flow rate, and thus the shear, at this location.

For mixing smaller quantities, systems have been developed which comprise a hand conveyor, double-chamber cartridge, and static mixer. The mixing energy is generated by the conveying pressure. When materials flow through the static mixer, which is composed of an outer housing and stationary mixing elements contained therein, the two individual components which are separate at the outset are mixed to produce a homogeneous mass. Both static and dynamic mixers are used in the dental field as disposable articles. After mixing is completed, the impression material remaining in the mixer is discarded along with the mixer.

For static mixers, helical mixers are typically used which for many years have proven to be suitable for mixing materials for impressions and bite registration. There are also chamber mixers, in which multiple chambers are arranged behind and adjacent to one another. The material flow is divided into multiple strands by means of connecting openings between the chambers, and these strands are recombined and intermixed. These mixers are known, for example, from US 5,851,067 and US 5,944,419, and are available for cartridges used for dental impression materials.

However, since they do not provide improved mixing for use with silicone impression materials, these mixers have not seen widespread use.

Further chamber mixers are known from EP 1 426 099 A1. The chamber mixers have at least two inlet openings, corresponding to the number of components to be mixed, and one outlet opening, and extend essentially between the inlet openings and outlet opening, whereby the number of chambers arranged one behind the other in the longitudinal direction is generally much larger than the number of chambers arranged side by side perpendicular to the longitudinal axis.

The mixing quality of the extruded and mixed impression material may be evaluated by chopping off, in a direction transverse to the flow direction, the paste strand exiting the mixer in the early stage of crosslinking. When mixing is poor, the cut surface reveals the formation of strips resulting from the presence of layers of different crosslinking states.

The reliability of existing methods is limited with regard to unintentionally improperly attached connections and the mixing of viscous components.

An object of the present invention is to improve the reliability of known systems, methods, mixers, and mixer elements for mixing dental impression materials made of polyether, and to reliably manage the known problems in particular with regard to the mixing quality and pressure load for high-viscosity components.

Therefore, the object of the present invention in particular is to develop a dynamic mixer for existing mixing devices which balances out fluctuations in the mixing ratio and at the same time provides satisfactory mixing for all consistencies used in the dental field without generating excessive heat in the product.

These measures are primarily intended to prevent back-curing of the components in the cartridge/bag after the mixing process, and at the same time to minimize the dynamic pressure in the mixer. It would also be advantageous to hold back to some

extent any “large” components which normally pass through at the beginning of the conveying process.

The object is achieved by a system, dynamic mixer, mixer parts, and mixing methods according to the independent claims. Advantageous embodiments are stated in the dependent claims. According to the invention, the features of the dependent claims may be combined in any given manner with features of other claims.

Possible approaches to achieving the object are represented by mixers in which a buffer chamber is present for receiving the multiple components which are initially needed in greater quantities. There is no separation of the buffer chamber and mixing chamber.

In preferred embodiments, back-curing and component lag are avoided by a buffer chamber having a deflecting element between the inlet opening and the mixing chamber.

A further preferred embodiment consists in providing devices in which at the start, a portion of the component is introduced into a chamber which can only be ventilated, but which has such narrow gaps or holes that the paste cannot flow through. This “dead” chamber does not represent a flow duct.

In the design of the actual mixing chamber and the mixing blades, the improvements are chiefly due to the effect of the thin mixer shaft. Specific designs and shapes of blades, to be described in greater detail below, have proven to be particularly advantageous.

A channel may be provided for introducing the second component in order to ensure the equality of the ratios in both ducts. However, this does not diminish the retaining effect of the other ducts/chambers.

Because of the high viscosity/filling rate sometimes required in technical applications for dental impression materials, any deflection of the material flow or narrowing of the flow cross section is associated with pressure buildup and frictional heat.

It is practical to strive for compatibility among existing cartridge systems. For this reason, all dimensions outside the dynamic mixer are specified. Inside the mixer housing, therefore, the aim is to achieve the greatest possible flow cross section and the least possible number of deflections and narrowings.

For this reason, elongated ducts as in EP 0 993 863/US 6,244,740, EP 1 029 585, and EP 1 099 470/US 6,523,992 are omitted. To receive the component which enters in excessive amounts at the start of conveying, a buffer chamber is used whose overall flow cross section is much greater than the product inlet opening.

To make more complete use of the buffer chamber, at least a portion of the inlet opening may be covered by a stationary deflection element.

In addition, a buffer chamber which is filled by a specialized configuration of the stationary deflection element and which is not suited for material flow because of the small size of the ventilation opening located at its end is advantageous for some consistencies.

In order to easily design the flow also in the mixing region, the cross-sectional area of the mixer shaft should not be greater than 1/5 of the internal cross section of the chamber section thus equipped. At locations where the product flows through, the distance between the mixer shaft and the chamber section may thus be set to at least 4 mm without unnecessarily increasing the external diameter and thus the volumetric capacity. To create the smallest possible impact surfaces in the material flow direction, it is advantageous to keep the individual mixing elements so narrow that at least 40% of the internal cross section of the chamber section may be utilized as a flow cross section surface, even on planes that are occupied by mixing elements.

To obtain adequate mixing quality in a mixer that is optimized for flow and low friction, it is practical to design and arrange the mixing elements in such a way that the mixing elements generate product flow which is aligned not only in the plane of rotation and the direction of conveying flow, but also opposite the direction of conveying flow and opposite the direction of centrifugal force. As the result of a trapezoidal shape or appropriate rounding of a portion of the mixing elements, a corresponding trapezoidal, triangular, or comparable flow opening may be provided which alternatingly conducts the product flow in and out.

By beveling or rounding at least a portion of the mixing elements in such a way that the mixing elements generate a partial flow originating partially in the direction opposite to the conveying flow direction, the mixer according to the invention may also produce adequate mixing quality, even for low viscosities.

To avoid negative pressure behind the mixing elements and entrainment of air bubbles which likewise impair the mixing quality, the side of the mixing elements oriented toward the chamber section may be at least partially beveled or rounded at parts of their edge facing away from the directions of conveying flow and rotation.

A further improvement in the mixing quality is achieved by also introducing the second component into the mixing chamber over the entire available radial width of the surface of the closing part facing the mixing chamber. To this end, the inlet opening is widened to form a channel which in a more or less curved or angled manner extends to the greatest possible extent from the mixer shaft opening to the chamber section.

In one preferred embodiment, at least a portion of the mixer axis located between the mixing blade planes has an expansion 14, 15 which narrows the flow cross section.

Similarly suited according to the invention, in particular for dental materials of various consistencies, is a dynamic mixer comprising a substantially cylindrical chamber section, at least in part, and having a discharge opening at the front end of the chamber section having a closing part situated at the rear end of the chamber section, with inlet openings for individual components to be introduced as well as a central opening for a mixer shaft which is rotatable about its longitudinal axis in the chamber section, having two planes axially positioned one behind the other, each having at least two mixing blades radially positioned one behind the other, at least a portion of the mixer axis located between the mixing blade planes (9) having an expansion of the mixer axis which narrows the flow cross section.

In further refinements of the mixer axis or the mixer according to the invention

- the expansion 14 has a square cross-sectional shape;
- the expansion 15 has a round cross-sectional shape.

In one likewise preferred embodiment, at least a portion of the mixer axis located between the mixing blade planes has a wall that runs eccentrically in the radial direction.

Similarly suited, in particular for dental materials of various consistencies, is a dynamic mixer comprising a substantially cylindrical chamber section, at least in part, and having a discharge opening at the front end of the chamber section and having a closing part situated at the rear end of the chamber section with inlet openings for individual components to be introduced as well as a central opening for a mixer shaft which is rotatable about its longitudinal axis in the chamber section, having two planes axially positioned one behind the other, each having at least two mixing blades radially positioned one behind the other, at least a portion of the mixer axis located between the mixing blade planes having a wall that runs eccentrically in the radial direction.

In special embodiments of this mixer axis or of this mixer,

- the parts of the mixer axis provided with a non-centrally running circumference have a substantially oval shape, and the cross-sectional midpoint thereof does not coincide with that of the chamber section.
- the parts of the mixer axis provided with a non-centrally running circumference have a substantially circular shape, and the cross-sectional midpoint thereof does not coincide with that of the chamber section.
- the planes (A-B-C-D, E-F-G-H) positioned axially one behind the other are radially offset with respect to the parts of the mixer axis provided with a non-centrally running circumference.

Also suited, in particular for dental materials of various consistencies, is a dynamic mixer comprising a chamber section with a discharge opening at the front end of the chamber section, and having a closing part situated at the rear end of the chamber section with inlet openings for individual components to be introduced, as well as a central opening for a mixer shaft which is rotatable about its longitudinal axis in the chamber section, whereby the mixing blade closest to the closing part extends over only a portion of the surface formed by the closing part, and the base plate for the closing part contains at least one flow perturbation element running in the flow direction and opposite the direction of rotation.

In advantageous embodiments of this mixer or of the base plate thereof,

- the flow perturbation elements 17 situated at the base plate of the closing part 5 extend substantially radially over the region of the base plate hollowed out by the mixing blades 16;
- the flow perturbation elements 17 situated at the base plate of the closing part 5 extend substantially axially up to the mixing blades 16;
- the flow perturbation elements 17 situated at the base plate of the closing part 5 extend far enough in the direction of rotation that in each resting position of the mixer axis 8 the flow perturbation elements together with the mixing blades 16 prevent direct product flow on the base plate between the two product inlet openings 6, 7.

In one embodiment, the dynamic mixer has a substantially cylindrical chamber section, at least in part, and a mixer shaft

- having a discharge opening at the front end of the chamber section,
- having a closing part with inlet openings for individual components to be introduced, situated at the rear end of the chamber section,
- and having a central opening for the mixer shaft which is rotatable about the longitudinal axis of the mixer shaft and of the chamber section, on which at least two mixing blades radially positioned behind one another are respectively located in at least two disk-shaped mixing blade planes axially positioned behind one another,
- and the feature that at least a portion of the mixer axis located between the mixing blade planes has an expansion of the mixer axis which narrows the flow cross section.

The expansion in general is designed in such a way that the mixer axis outwardly deviates from the cylinder shape at the particular location. The expansion may be an arch, for example, or may project in a wedge shape from the mixer axis, so that the cross section of the expansion has a polygonal or circular cross-sectional shape. The side of the expansion projecting opposite the chamber section may be beveled or rounded.

The expansion may also be designed so that the mixer axis deviates from the cylindrical shape at the particular location in such a way that an overall hemispherical or hemiellipsoidal cross section results.

All deviations from the cylindrical shape may also be offset along the mixer axis, so that different mixing planes may have differently situated or shaped deviations.

Another possibility for avoiding plug flow lies in providing the mixer shaft on the planes not occupied by mixing blades, eccentrically with respect to the rotational

axis. This is achieved, for example, when the shaft has an oval cross section. Similar to a camshaft, the shaft may also have a design that is circular or disk-shaped in sections, and may have planes that are eccentrically offset with respect to one another. For an eccentrically offset configuration of the planes, however, these may also have a polygonal design.

The above-described flow perturbation elements are a part of the rotor, and therefore are understood to represent a deviation of the axial product-conveying flow.

An important region for the mixing effect for reactive components is the region in which these components first meet. Undesired spontaneous reactions may result if unmixed layers remain in contact with one another at this location.

For this reason, flow perturbation elements have proven to be advantageous, particularly in this region.

This is achieved, for example, by reaching the advantageous high peripheral velocity of the outer region for mixing by the fact that the mixing blades extend to the greatest possible extent up to the housing wall and the base of the closing part. It is advantageous to completely hollow out the mixing blade in the transition region from the closing part and the mixer shaft, and to provide one or more flow perturbation elements at the base of the closing part.

If these flow perturbation elements for the closing part are provided partially circumferentially around the mixer shaft in a block, wedge, or ramp shape, the flow perturbation elements in cooperation with the mixing blades facing the inlet openings may prevent direct product flow of the component into the inlet opening for the other component after the mixing process is completed.

According to the invention, systems for producing dental impression materials are provided in which dental materials of different consistencies are extruded from supply containers into the mixer while being kept isolated from one another. It is

suitable for the outlet openings of the supply containers to be matched to the inlet openings of the mixer. This system comprises a plurality, in particular at least three, preferably at least four of the following elements:

a) a buffer reservoir, expanded with respect to an inlet opening, which is not separate from the mixing chamber;
b) a strand divider situated in the buffer reservoir;
c) an element at the smaller opening of the mixer or the supply container which prevents the larger opening of the supply container or the mixer from being placed thereon;
d) a minimum distance of 4 mm between the mixer shaft and the chamber wall;
e) a mixer shaft whose cross-sectional area is a maximum 20% of the cross-sectional area between the chamber walls;
f) a mixer shaft together with mixing elements which have a combined cross-sectional area that is less than 60% of the cross-sectional area between the chamber walls;
g) a mixer axis having an expansion which narrows the flow cross section;
h) a mixer shaft whose mixer axis located between the mixing blade planes has a wall running eccentrically in the radial direction;
i) a closing part having a flow perturbation element running in the flow direction, opposite the direction of rotation;
j) the mixing blade closest to the closing part is designed such that the mixing blade can extend over only a portion of the surface formed by the closing part.

In a corresponding method for producing dental impression materials, dental materials of different consistencies are extruded from supply containers and mixed to form an impression material. To this end, the dental materials are extruded from the supply containers into a mixer, the mixer having inlet openings matched to the outlet openings of the supply containers, and implementing a plurality, in particular at least three, preferably at least four of the following features:

k) a component to be mixed is kneadable, and in particular is fed to a mixer having a supply chamber;

l) the supply chamber is not separated from the mixing chamber;

m) the components to be mixed are fed to a mixer shaft whose cross-sectional area is less than 20% of the cross-sectional area of the chamber section;

n) the mixer shaft together with the mixing elements occupies less than 60% of the cross-sectional area of the chamber section;

o) the strand extruded into the buffer reservoir is divided by means of a strand divider in the buffer reservoir;

p) the smaller inlet opening of the mixer is prevented from being placed on the larger opening of the supply container by means of at least one element;

q) the mixer axis has an expansion of the mixer axis, situated at least partially between the mixing blade planes, which narrows the flow cross section;

r) at least a portion of the mixing elements mounted on the mixer shaft (8) partially generate a mass flow in the direction opposite to the conveying direction;

s) the mass to be mixed is conveyed alternatingly in the radial direction from the outside to the inside, and vice versa.

According to the invention it has been found that a static chamber mixer is suitable for mixing the components of polyether impression materials. Polyether impression materials are understood to mean, among other things, products based on silane-terminated polyethers as well as products based on aziridine-terminated polyethers. Thus, a method is also provided for mixing the components of polyether impression materials, in which a static chamber mixer is used. This represents the first use of a static chamber mixer for mixing polyether impression materials, in particular the first use of a static chamber mixer for mixing impression materials based on silane-terminated polyethers, or the use of a static chamber mixer for mixing impression materials based on aziridine-terminated polyethers.

Surprisingly, it has been shown that polyether impression materials may be mixed particularly well using static chamber mixers, as known from EP 1 426 099 A1, for example, the content of which is expressly referenced with respect to the content of the disclosure of the present invention. The widely used silicone impression

materials may likewise be mixed well using static chamber mixers as well as static helical mixers. In contrast, the polyether impression materials finding increasing use in recent times unexpectedly may be mixed significantly better with chamber mixers than with helical mixers. This is unexpected to one skilled in the art, in that such a person initially would assume that both materials have similar mixing capabilities.

This method according to the invention may be carried out, for example, using a mixer according to EP 1 426 0999 [sic; 1 426 099] A1. The impression materials used are known from EP 269 819 B1, for example. A conventional double-chamber cartridge having in both of its chambers the two starting components of a silane-terminated polyether impression material to be mixed, in a 2:1 volume ratio, is connected to the inlet opening of the chamber mixer. The components are extruded through the chamber mixer by pressing on the cartridge and are thus mixed. It has been shown that the two components are mixed to form a homogeneous product. The strip buildup which occurs when helical mixers are used (the product may be divided into layers in an early state of crosslinking) is completely or essentially completely absent for chamber mixers. By use of a chamber mixer, the formation of strips may also be avoided for impression materials based on aziridine-terminated polyethers.

Embodiments of the invention are described in greater detail in the drawings, which show the following:

Figure 1	shows a mixer having the buffer chamber 22;
Figure 2	shows the rounded end 20 of the buffer chamber;
Figure 3	shows, in a view rotated by 90° with respect to Figure 2, the beveled edge 19 of the buffer chamber 22;
Figures 4 and 5	show the variant in which the end of the buffer chamber does not run at right angles to the plane of rotation;
Figures 6 through 8	show deflection elements;
Figures 9 and 10	show the buffer chamber 22 between the inlet opening 7 and the mixing chamber 21 with ventilation slits 50, 51, 52;

Figure 11	shows ventilation openings 53, 54 which are shaped as round or polygonal holes;
Figures 12 through 15	show design possibilities for the mixing elements;
Figure 16	shows a dynamic mixer for dental materials according to the invention, in cross section;
Figures 17 and 18	show the mixer axis in cross section, with a circular and square design, respectively, of the expansion;
Figures 19 and 20	show embodiments and positionings of the oval mixer axis and of the mixing blades;
Figures 21 and 22	show asymmetrical configurations of the circular mixer axis;
Figure 23	shows the configuration of the flow perturbation elements on the closing part;
Figure 24	shows the embodiment of the closing part with flow perturbation elements, in cross section.

Figure 25 shows the dynamic mixer in the front view, comprising a chamber section 1, mixer shaft 8, and closing part 5 having the two inlet openings 6, 7 and the positioning aid 40.

Figure 26 shows the dynamic mixer in the front view, placed on the two outlet supports 44, 46 for the tubular bags 47, 48, in which the two outlet supports 44, 46 for the tubular bags 47, 48 have different diameters, and the outlet support 44 is externally 39 placed on the inlet opening 6 in a sealing manner.

Figure 27 shows the dynamic mixer in the side view, placed on the outlet support 44 for the tubular bag 47, in which the outlet support 44 is externally 39 placed on the inlet opening 6 in a sealing manner past the positioning aid 40.

Figure 28 shows the dynamic mixer in the front view, placed on the two outlet supports 45, 46 for the tubular bags 47, 48, in which the two outlet supports 44 [sic;

45], 46 for the tubular bags 47, 48 have different diameters, and the outlet support 45 is internally 38 inserted into the inlet opening 6 in a sealing manner.

Figure 29 shows a closing part 5 having two bar-shaped positioning aids 40 in the vicinity of the inlet opening 6 without contacting same.

Figure 30 shows a closing part 5 having two strip-shaped positioning aids 41 in the vicinity of the inlet opening 6 without contacting same.

Figure 31 shows a closing part 5 having circular positioning aids 42 around the inlet opening 6 without contacting same.

Figure 32 shows a closing part 5 having semicircular positioning aids 43 in the vicinity of the inlet opening 6 without contacting same.

One embodiment of the invention is a dynamic mixer, in particular for dental materials of various consistencies, comprising a chamber section having a discharge opening at the front end of the chamber section, and a closing part situated at the rear end of the chamber section having a base plate, inlet openings for individual components to be introduced, and a central opening for a mixer shaft which is rotatable about its longitudinal axis in the chamber section, the inlet opening 7 for the component ("multi-component") present in the greater quantity expanding outside the region of the chamber which is accessible to the mixing elements to a buffer reservoir 8.

At least one of the following features is preferably present:

- the individual components are present in a mixing ratio different from 1;
- the total area of the inlet openings for one component is different from the total area of the inlet openings for another component;
- the buffer reservoir 22 extends around the inlet opening 7, in particular in a radial manner on both sides of the inlet opening 7;

- at least one end 9 of the buffer reservoir 22 adjoining the closing part 5 is, at least in part, not at a right angle to the plane of rotation;
- at least one end 20 of the buffer reservoir 22 has a rounded shape, at least in part;
- at least one end 49 of the buffer reservoir 22 adjoining the closing part 5 has a beveled shape, at least in part;
- the buffer reservoir 9 extends at least 90° over the base plate;
- at least a portion of the inlet opening 7 is covered by a stationary deflecting element 11;
- the area of the deflecting element 11 facing the mixing chamber is smaller than the sum of the outlet openings 12 for the buffer chamber 22;
- the sum of the flow cross-sectional areas of the buffer chamber is greater than that for the inlet opening 7;
- the deflecting element 11 is rounded on its edges;
- the deflecting element 11 is beveled on its edges;
- the deflecting element 11 has a separating edge 13 on its side facing the inlet opening for dividing the product flow; and
- the deflecting element 11 is centrally positioned over the inlet opening 7.

A further embodiment is a dynamic mixer, in particular for dental materials of various consistencies, comprising a chamber section 1 having a discharge opening 2 at the front end 3 of the chamber section, and a closing part 5 situated at the rear end 4 of the chamber section having inlet openings 6, 7 for individual components, which are present in quantity ratios different from 1, to be introduced and mixed, and a central opening for a mixer shaft 8 which is rotatable about its longitudinal axis in the chamber section 1, the dynamic mixer having a buffer chamber 22, situated between the inlet opening 7 and the mixing chamber 21, which is not used as a flow duct for one of the components.

In this embodiment at least one of the following features is preferably present:

- the buffer chamber 22 has at least one ventilation opening 50, 51, 52, 53, 54 situated away from the mixing chamber 21, the cross-sectional area of the ventilation opening being much smaller than that of the inlet opening 7;
- the inlet opening 50 is axially provided in the shape of a slit at the end of the buffer chamber 22;
- the inlet openings 51, 52 are radially provided in the shape of a slit at the exterior and/or the interior of the buffer chamber 22;
- the inlet openings 53, 54 are provided as round or polygonal holes; and
- the inlet openings 50, 51, 52, 53, 54 narrow toward the mixing chamber.

A further embodiment is a dynamic mixer, in particular for dental materials of various consistencies, comprising a chamber section 1 having a discharge opening 2 at the front end 3 of the chamber section, and a closing part 5 situated at the rear end 4 of the chamber section having inlet openings 6, 7 for individual components, which are present in quantity ratios different from 1, to be introduced and mixed, and a central opening for a mixer shaft 8 which is rotatable about its longitudinal axis in the chamber section 1,

- both components entering the mixing chamber 21 over the available radial width of the closing part 7 [sic; 5].

In this embodiment at least one of the following features is preferably present:

- at least one inlet opening 6 branches to a channel 18 that is open toward the mixing chamber side;
- the channel 18 runs in a curved or angled manner; and
- the edge 19 of the channel 18 located in the direction of rotation is rounded or beveled.

A further embodiment is a dynamic mixer, in particular for dental materials of various consistencies, comprising a chamber section 1 having a discharge opening 2 at the front end 3 of the chamber section, and a closing part 5 situated at the rear end 4 of

the chamber section having inlet openings 6, 7 for individual components, which are present in quantity ratios different from 1, to be introduced and mixed, and a central opening for a mixer shaft 8 which is rotatable about its longitudinal axis in the chamber section 1,

- the distance between the mixer shaft 8 and the chamber section 1 is not less than 4 mm at any location; or
- the cross-sectional area of the mixer shaft 8 is less than 20% of the cross-sectional area of the chamber section 1; or
- the cross-sectional area of the mixer shaft 8, including the mixing elements 23, 28, 27, 30, is less than 60% of the cross-sectional area of the chamber section 1.

The mixing elements have different designs. Mixing elements 23 having an impact surface 24 in the direction of rotation, parallel to the mixer axis, and being narrower 25, 27 to the rear, at least in part, have proven to be suitable.

It is also advantageous for at least a portion of the mixing elements 23 on the mixer shaft 22 to partially generate a mass flow opposite the conveying direction by the fact that at least one of the surfaces 26 running in the radial plane is beveled away from the product flow.

In particular, as a result of the position and shape of the mixing elements 28, 29, 30 attached to the mixer shaft 22, the mass to be mixed may be conveyed alternatingly in the radial direction from the outside to the inside, and vice versa.

It may also be advantageous for at least a portion of the mixing elements 28 attached to the mixer shaft 22 to be beveled and axially positioned with respect to one another in such a way that they form a conical flow duct 31, 32; or that

- at least a portion of the mixing elements 28 is radially positioned behind one another so that the conicity 31, 32 is alternating oriented outward and inward;

- or that at least two of the mixing elements 29, 30 attached to the mixer shaft 22 in the axial direction with respect to one another are partially interconnected 33, 34, 35, 36.

The connections 33, 34, 35, 36 of the mixing elements 29, 30 are advantageously established on the radial plane, alternatingly oriented outward and inward.

The connection 33, 34 of the mixing element 30 may describe an arc 37 with respect to the product flow side.

Figure 16 shows the dynamic mixer, comprising a substantially cylindrical chamber section 1, at least in part, having a discharge opening 2 at the front end 3 of the chamber section, and a closing part 5 situated at the rear end 4 of the chamber section having inlet openings 6 and 7 for individual components to be introduced, and a central opening for a mixer shaft 8 which is rotatable about its longitudinal axis in the chamber section 1, having at least two planes 9 axially positioned one behind the other, each having at least two mixing blades 10 radially positioned one behind the other, with the feature that at least a portion of the mixer axis 8 located between the mixing blade planes 9 has an expansion 14, 15 on the mixer axis 8 which narrows the flow cross section 54.

Figure 17 shows the polygonal (in this case square) design of the expansion 14, as well as the mixing blades 10.

Figure 18 shows a circular design of the expansion 15, corresponding to Figure 17.

Figure 19 illustrates the mixing axis, which is provided with radially offset expansions in planes A–D. This is clearly identified by the projections in planes B and D.

Figure 20 shows the corresponding cross-sectional views of planes A–D, the axis 57 with the expansions having an oval cross section.

Figure 21 shows, corresponding to the illustration in Figure 19, the variant in which the axis has eccentrically positioned disks with spherical cross sections in the planes E–H. Figure 21 also illustrates how the mixing blade 16 closest to the closing part 5 extends over only a portion of the surface formed by the closing part 5, and the base plate of the closing part 5 contains at least one flow perturbation element 17 running in the flow direction, opposite the direction of rotation. The flow perturbation elements 17 situated on the base plate of the closing part 5 extend substantially radially over the region of the base plate hollowed out by the mixing blades 17, and/or substantially axially up to the mixing blades 17.

In one advantageous embodiment, the flow perturbation elements 17 situated on the base plate of the closing part 5 extend so far in the direction of rotation that, together with the mixing blades 16, in any resting position of the mixing axis 8 they prevent direct product flow on the base plate between the two product inlet openings 6 and 7.

The surfaces of the flow perturbation elements 17 facing the direction of rotation preferably have an angle of inclination of 10° to 80° relative to the base plate. The surface(s) of the flow perturbation elements 17 facing away from the direction of rotation preferably have an angle of inclination of 80° to 90° relative to the base plate.

In Figure 22 the individual planes E–H are illustrated in cross section, clearly showing the offset configuration of the disks on the axis 58.

Figure 23 (and Figure 24) show an embodiment in which two flow perturbation elements 17 running in the flow direction, opposite the direction of rotation, are situated on the base plate of the closing part. The flow perturbation elements may extend substantially radially over the region of the base plate hollowed out by the mixing blades 16, or substantially axially up to the mixing blades 16. It is desirable for the flow perturbation elements 17 situated on the base plate of the closing part 5 to extend so far in the direction of rotation that, together with the mixing blades 16, in

any resting position of the mixing axis 8 they prevent direct product flow on the base plate between the two product inlet openings 6, 7. The surfaces of the flow perturbation elements 17 facing the direction of rotation generally have an angle of inclination of 10° to 80° relative to the base plate. The surfaces of the flow perturbation elements 17 facing away from the direction of rotation advantageously have an angle of inclination of 80° to 90° relative to the base plate in the direction of rotation.